Monitoring labor activity

During labor, the uterus muscle starts contractions of increasing intensity in a bid to expel out the child. The intrauterine pressure can reach values of 150 mmHg or more during the expulsion period. However, a normal patient in spontaneous active labor will demonstrate uterine contractions occurring at intervals of three to five minutes, with duration of 30-70 s and peak intensity of 50 to 75 mmHg.

Each uterine contraction diminishes placental perfusion and acts as a transient stress to the fetus, which may be damaged by excessive contractility or by prolonged duration of labor. Some patients will spontaneously exhibit much lower uterine activity, in terms of intensity and frequency of contractions than others but will still show progressive cervical dilation and an otherwise normal progress of labor.

The labor activity can be recorded either in terms of the intra-uterine pressure measured directly by means of a catheter or a relative indication of the labor intensity measured through an external transducer. A plot of the tension of the uterine wall is obtained by means of a spring loaded displacement transducer.

The transducer performs a quasi-isometric measurement of the tension of the uterus. The transducer carries a protruding surface of the transducer is displaced as the tension in the uterus increases. This movement is converted into an electrical signal by a strain gauge in the transducer housing. The abdominal transducer provides a reliable indication of the occurrence frequency, duration and relative intensity of the contraction.

The transducers are location sensitive. They should be placed over the fundus where there is maximum motion with the contraction. The transducer cannot be used in the same place as the fetal heart rate detector, thus the patient must have two transducers on her abdomen.

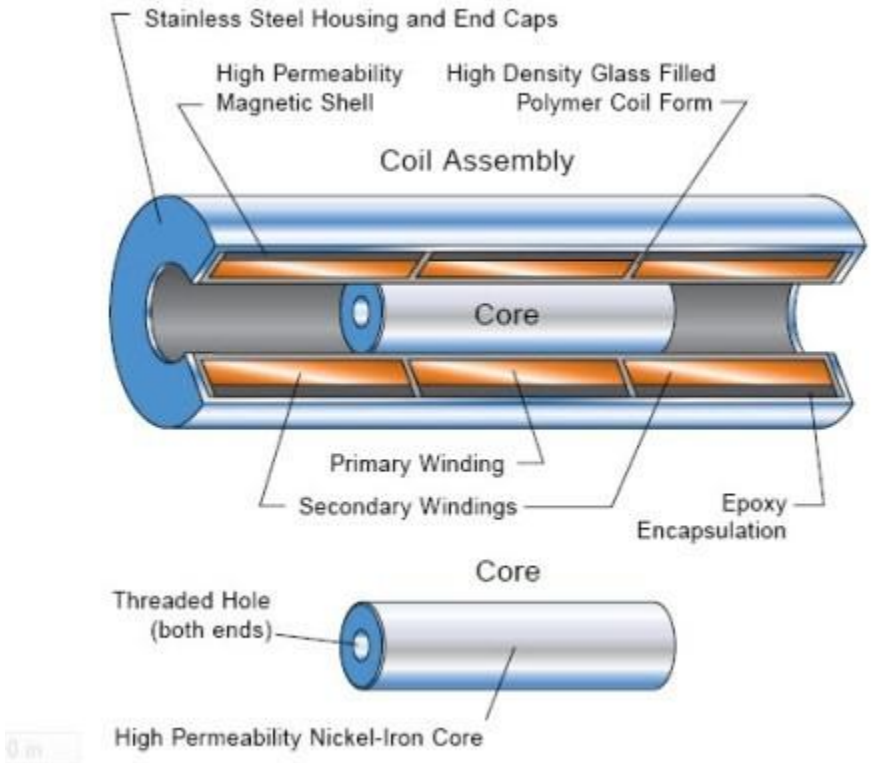
To sense uterine contractions externally, it is necessary to press into the uterus through abdominal wall. Resistance to pressure is measured either by the motion of a spring or the force needed to prevent a button from moving.

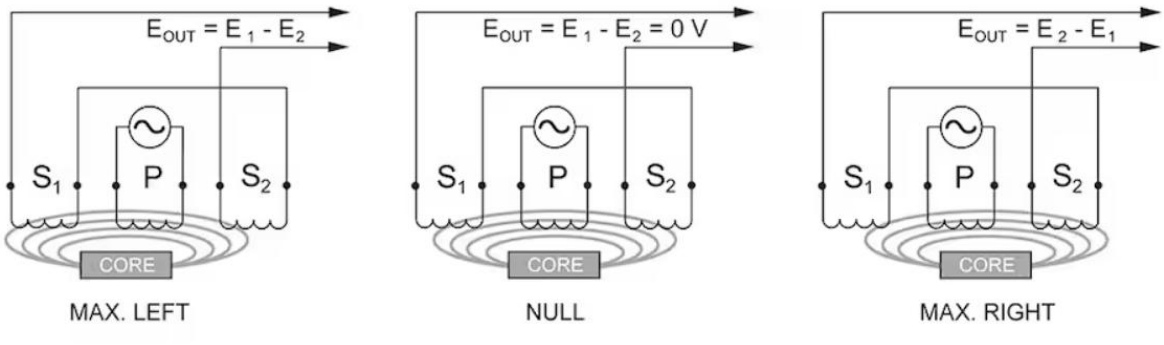
External strain gauges are used to measure and record the bending of a spring. In some instruments, a crystal which changes electrical characteristics with applied pressure is used to measure force against a plunger. This method is automatic and provides pertinent information.

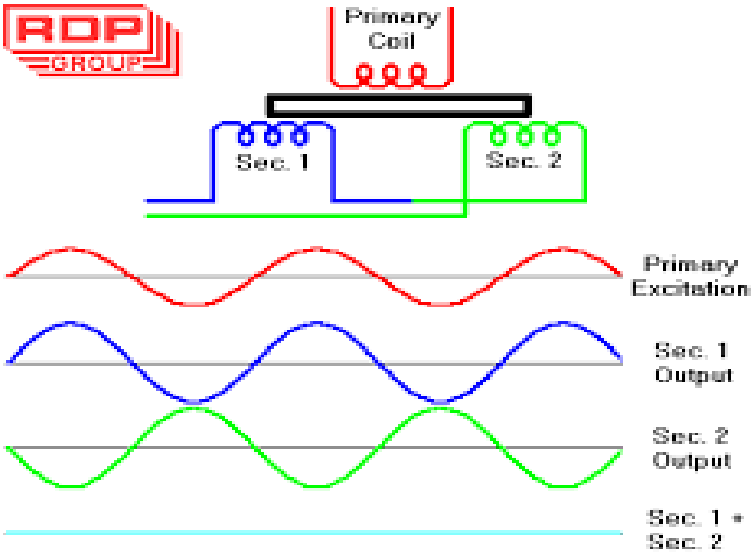
Figure below shows a block diagram of the circuit which measures labor activity externally. The utilized transducer is linear variable differential transformer (LVDT) transducer.

Figure below illustrates what happens when the LVDT's core is in different axial positions. The LVDT's primary winding, P, is energized by a constant amplitude AC source. The magnetic flux thus developed is coupled by the core to the adjacent secondary windings, S1 and S2. If the core is located midway between S1 and S2, equal flux is coupled to each secondary so the voltages, E1 and E2, induced in windings S1 and S2 respectively, are equal. At this reference midway core position, known as the null point, the differential voltage output, (E1 - E2), is essentially zero. As shown in Figure 2, if the core is moved closer to S1 than to S2, more flux is coupled to S1 and less to S2, so the induced voltage E1 is increased while E2 is decreased, resulting in the differential voltage (E1 - E2). Conversely, if the core is moved closer to S2, more flux is

coupled to S2 and less to S1, so E2 is increased as E1 is decreased, resulting in the differential voltage (E2 - E1).



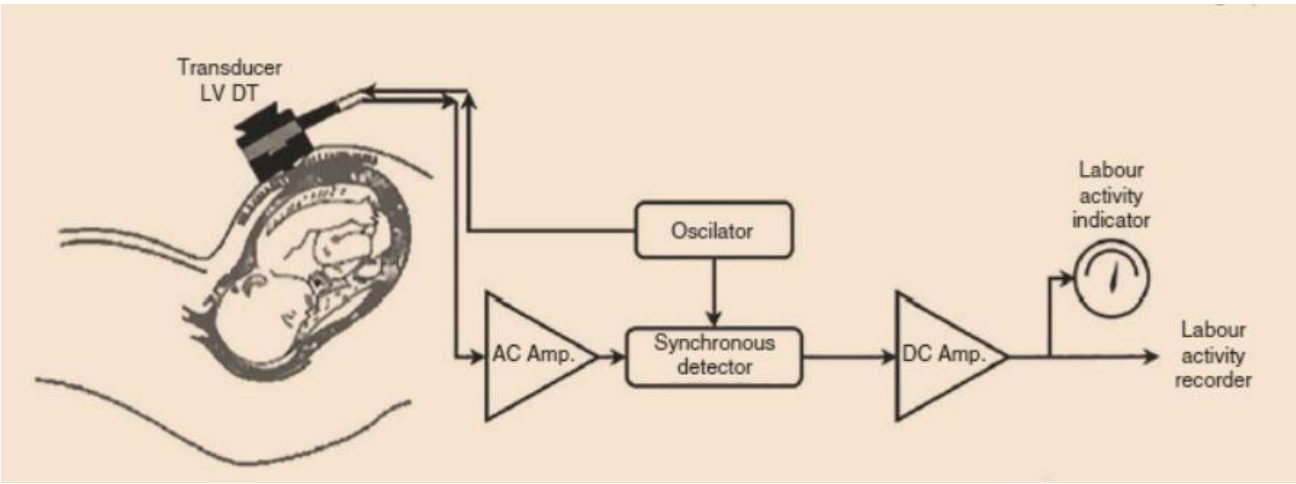




The transducer output is amplified in an AC amplifier. The low frequency labor activity signal is obtained from the synchronous detector and is further amplified by a dc amplifier. The activity can be either displayed on a meter or on a direct writing chart recorder.

The labor-activity transducers are pressure transducers that drive circuits for obtaining an electrical indication of pressure by conventional means.

The pressure channel on the recorder is provided with a positioning control. This is done because the baseline is affected by the static pressure on the transducer that results from the tension on the belt holding the traducer in place, the control permits the operator to position the base line on the zero-level line of the recording chart.



Labour Activity Monitor block diagram.

In external toco-tonometry, movement of the fetus may be superimposed on the labor activity curve. Stress imposed on the fetal circulatory system by the uterine contractions, fetal movements or other factors are seen in the response of the fetal heart to these stimuli and are studied in the correct time relationship.

The internal method measures intra-uterine pressure (IUP) via a fluid-filled catheter. The catheter is inserted into the uterus through a guide after the rupture of the fetal membranes. After allowing free flow of amniotic fluid to ensure correct placement, the distal end of the catheter is usually attached to a pressure transducer of the type used for cardiac studies.

Changes in amniotic pressure are easily transmitted to the gauge by the incompressible fluid in the catheter. The pressure transducer converts the catheter pressure into an electrical signal which can be displayed on the strip chart recorder.

Strain gauges, though very accurate, tend to drift up to several mmHg/h or drift with temperature changes. Therefore, when continuous monitoring is employed, it is necessary to set zero and calibrate the transducer frequently. The peak pressure may vary according to which catheter is placed in the uterus. It is necessary to flush the catheter system to avoid any blockage and to maintain the frequency response.

Although the system is inherently capable of having great accuracy, catheter-obtained uterine contraction date may be distorted or inaccurate. The IUP may be accurately recorded only as long as a fluid pool is sustained around the tip of the catheter and leakage is completely controlled by the descending fetal head.

Since there is no real control of catheter placement, it may slip into an isolated pocket and receive very high pressure, especially if there is little fluid, also, the uterus only approximates a closed fluid chamber, and pressures are not necessarily transmitted equally to all segments. Open segments tend to lose fluid and thus may generate lower pressures. One study showed that IUP varies by as much as 25% at different points in the uterus. Thus, the physiological measurement does not approach the instrument in accuracy or reproducibility.